

proper development at a time when growth is very rapid, and thus cause that difference in the length and strength of the limbs remarked by your correspondents?

SARA S. OWEN

4, Soames Street, Grove Park, S.E., February 2

ON THE HEIGHT OF THE AURORA BOREALIS

IT is with pleasure that I respond to the invitation of NATURE to give an account of the work of the Danish Meteorological Station, which was maintained, under the international scheme, at Godthaab in Greenland, in 1882-83, and of which I had the honour of being the chief. I intend, in the present article, to confine myself to the aurora borealis.

The results, which have been obtained from calculations of the height of the aurora borealis in the temperate zone, which lies south of the so-called auroral belt, all agree in fixing the minimum height of the aurora very high, as the auroræ seem to be confined to the part of the atmosphere where its density is only a fraction of that at the surface of the sea. However different the value may have been of the heights of the auroræ observed outside their true zone, the average of the minimum heights is hardly under two hundred kilometres. On the other hand, the observations in the Arctic regions show that the auroræ may descend to much lower elevations above the earth's crust, and that they may even reach down into regions of the atmosphere where the density is about the same as on the surface of the sea.

Dr. S. Fritz has thus, at Ivigtut in South Greenland, in February and March, 1872, measured auroræ the lower edges of which were only from 50 to 200 metres above the level of the sea, while in nearly every monograph of the aurora borealis cases are cited in which the auroræ appear to have reached much further down in the atmosphere. I may further mention some instances, which have, by the bye, not been made public before, observed by the eminent zoologist, Prof. Steenstrup, and which he has permitted me to publish here.

During Prof. Steenstrup's sojourn in Iceland, 1839-40, he saw, on several occasions, auroræ which hid the top of the mountain Esia, some 600 metres in height, lying behind Reykjavik. He further states that he has seen auroral streamers between the masts of a ship, in such a manner that they disappeared where there were sails, and reappeared where the space was free. The Professor asserts even that on one occasion, on January 28, 1840, when walking between Reykjavik and Bessastad with the chief magistrate, Herr Tvede, and Judge Jonasson, he, as well as these two gentlemen, saw auroral streamers appearing *between themselves*. The phenomenon was not a solitary one, but occurred three or four times during this walk, and in spite of the pedestrians keeping about a yard from each other.

Although many estimates of the low descent of auroræ in the Arctic regions may have been due to optical illusions, specially through irradiation, one cannot, even from a casual observation of this magnificent phenomenon, but come to the conclusion that, while some auroræ lie in the same great, indefinable distance from the observer as those observed in the temperate zone, there are others whose whole appearance has the character of being a phenomenon of a purely local nature. During our stay at Godthaab this point had my special attention, as it appeared to me of importance to demonstrate by measurements as accurate as possible whether this subjective impression answered to the true facts.

To this end the Danish international station at Godthaab, 64° 10' 36" N. lat. and 51° 40' 0" E. long., has, during October and December, 1882, effected a series of measurements. The site of the station was particularly suited for the solution of the problem, as it lies just at the northern border of the great Arctic auroral belt, *i.e.* in a place where the auroræ appear with all the peculiarities which distinguish them in their true zone.

The distance between the two points of observation, separated by the Godthaab Fjord, was 5·8 kilometres, and the direction between them coincided with the magnetic meridian. The two instruments used for the measurements, exactly similar in construction, were arranged as universal instruments. Instead of a telescope, a tube was employed, which had in one end a small opening, and in the other a metal cross of very fine wires. In order that the errors in the observations should not affect them very much, measurements were only made in the vertical plane between the two points of observation. The placing and reading of the instruments were effected by means of pre-arranged fire-signals, and only those measurements of which the reading signals were instantaneously answered, and for which the time of reading exactly coincided, were recorded. Only the lower edges of the auroral bands were measured, as these are nearly always the most clearly defined.

We have, during our evenings of observation, measured the height of thirty-two auroral bands. The subjoined figures, showing the result of these, demonstrate that the lower edge of the band certainly descends very low. Thus of the thirty-two auroræ measured by this method ten only had a parallax under 1°, for six the parallax was between 1° and 2°, four had a parallax of between 3° and 4°, two one between 5° and 6°, four one between 7° and 8°, while we measured six of 10°, 14°, 15°, 17°, 86°, and 143° respectively.

Leaving the auroræ whose parallax was under 1° out of the calculation, I have found the following heights for the other twenty-two lower edges:—

1 ...	67·81 kilometres.	...	12 ...	7·43 kilometres.
2 ...	59·60	..	13 ...	6·16
3 ...	54·73	..	14 ...	5·28
4 ...	46·94	..	15 ...	3·72
5 ...	45·04	..	16 ...	3·69
6 ...	38·09	..	17 ...	3·22
7 ...	29·81	..	18 ...	2·87
8 ...	19·14	..	19 ...	1·99
9 ...	9·76	..	20 ...	1·96
10 ...	9·40	..	21 ...	1·35
11 ...	7·67	..	22 ...	0·61

The three heights of 1·99, 2·87, and 3·22 kilometres belong to the same aurora as that whose edge was measured at an interval of two minutes between each measurement. The two auroræ of 1·35 and 0·61 kilometres stood both above the fjord between the observatories. From the southern one they were seen at an altitude of 13°·6 and 30°·3 respectively above the northern horizon, while at the northern station they were 80°·5 and 7°·25 respectively above the southern horizon. These two and the above-mentioned third, the height of which was measured three times, had the appearance of curtains with large folds, or of bunches or wreaths of streamers lying close together, separated by darker, faintly-shining spaces, but connected below through a common band. The others were bands or arcs without radiating streamers. The edges measured were all nearly at right angles with the magnetic meridian. Only the height of those edges which were distinctly defined, and whose course did not deviate greatly from perpendicularity on the magnetic meridian, were measured.

I must further, as regards the small height of the auroræ observed at Godthaab, state that not only three observers besides myself, but even a student as conversant with auroral phenomena as Herr Kleinschmidt, all agree that auroræ were seen *below the clouds* on several occasions during the winter of 1882-83. On this point we do not entertain the least doubt.

In conclusion I will describe some observations made on several occasions during our stay at Godthaab of the peculiar type of the aurora known as phosphorescent auroral clouds.

On September 21, 1882, Herr C. Petersen, one of my

assistants, observed, at 9.45 p.m., an aurora appearing as a lustrous green light behind the nearest hills. The top of the mountain, "Sadlen," 1200 metres in height, was distinctly seen *above* the lustrous plane. The phenomenon rapidly disappeared. At 10.45 a light was seen in the south, which resembled that of dawn, and contracted into a faint shining cloud, oblong in shape, which oscillated slowly before the mountains "Hjortetakken" (1200 metres) and "Store Malene" (800 metres) at a distance of 8 to 12 kilometres from the station. The tops of the two mountains were distinctly seen *above* the luminous cloud, while at times small but intense spots of light developed themselves in it. When the cloud, at 11.45 p.m., had moved in front of the mountain "Lille Malene," the light became more intense, and had the appearance of a lustrous white cloud of smoke rolling up the hill to north-east. When the cloud travelled over the hill, the light became yellow, and was bordered by a coloured rim. At 11.10 it shot three faint red streamers up towards the zenith, and then the whole disappeared.

The following phenomenon was observed by the writer of these lines:—On November 14, 1882, at 6 a.m., I observed an auroral band without streamers through Vega, the Great Bear, and the Twins, while another stood parallel with this further west. From the "Store Malene" I now saw a peculiar shining white cloud descend into the fjord below. It descended in long, straight, shining bands. In a few minutes the mountain in question, as well as "Hjortetakken" were completely hidden in the cloud. A little further east the cloud possessed greater intensity, while on the plain at the foot of the hill on which the observatory stands, two luminous gatherings were seen, which seemed to rest on the snow, with a strongly phosphorescent light. These two gatherings, which were at first isolated, now came in contact with the above described cloud with long luminous bands radiating from the latter. By opening the slit of the spectroscope as much as possible and simultaneously keeping foreign light from the eye, I beheld the auroral line faintly but clearly defined. The cloud now began to disappear without oscillation, when suddenly a number of horizontal openings formed in it, through which the mountain stood forth. In the next second all had disappeared.

I admit that, as regards the last described phenomenon of the lustrous cloud, it might be explained as being caused by the reflex of the auroræ which were simultaneously visible; but such an explanation is not applicable to the one first described. It would be very interesting to learn if other observers have noticed this form of the aurora.

ADAM PAULSEN

Copenhagen

THE EFFECTS OF THE WEATHER UPON DEATH RATE AND CRIME IN INDIA

SOME time ago a very interesting series of articles, by Mr. Buchan, upon the connection between certain meteorological conditions and the zymotic diseases, as illustrated by the mortuary returns of the London district, appeared in NATURE. Happening to have undertaken, at the request of the provincial superintendent of census operations, certain investigations concerning the life statistics of the population of the North-West Provinces and Oudh, just about the time when Mr. Buchan's articles appeared, it occurred to me that it would be worth while to see whether any similar concomitant variations of meteorological conditions and causes of death could be detected in India. The results arrived at are so curious, and at the same time so definite, that I think they may be of interest to readers of this journal.

At starting, however, it should be observed that, though the mortuary returns of the province with which I am connected are probably the best in India, they are

still very far from complete. The agency employed for registration is that of the village *chaukidâr* or watchman, who is supposed to take note of all births and deaths which occur in his village (aiding his memory, if necessary, by variously cut notches on a stick) and to report these weekly at the nearest police station. From such an agency nothing like an exact account of the causes of death can be expected; hence in the detailed tables given below I have confined my attention to the four most obvious causes—small-pox, cholera, suicide, and wounds. Even as regards the number of deaths registered a considerable defect may confidently be anticipated, owing to lapses of memory on the part of the *chaukidâr*. This defect has been found by Dr. Plauck, the Sanitary Commissioner, to amount to about 20 per cent. of the whole on the average of a large number of cases personally examined by him in various parts of the province. The proportion thus obtained is confirmed by a comparison of the deaths actually registered with the death rate arrived at in the last census report. During the five years, 1878-82 (the only ones for which complete returns are obtainable), the deaths registered appear, from figures supplied by Dr. Plauck, to have numbered 7,311,013. The average population during the five years having been about 45,000,000, this gives an annual death rate of 32.5 per thousand. Now in Mr. White's report on the census of 1881 it is shown that the distribution of the population according to age, and the observed death rate among certain tribes and castes suspected of practising infanticide, and therefore placed under strict police surveillance, point to 40 per mille as the probable rate of mortality for the general population. The unrecorded deaths therefore amount on the average to 7.5 out of 40, or 19 per cent. of the total—almost exactly the same defect as Dr. Plauck arrived at by his personal investigation of special cases.

It follows that, though the returns collected by the rude illiterate agency employed are not strictly accurate, the totals arrived at probably on the whole bear a nearly constant proportion to the true number of deaths, the population dealt with being sufficiently numerous to eliminate any individual peculiarities of the agents.

The death rate varies enormously from year to year, as may be seen from the table of the total number of deaths recorded, here given in full:—

Number of Deaths from all Causes Registered in the North-West Provinces and Oudh during the Five Years 1878-82

Year	Jan.	Feb.	March	April	May	June	July
1878	137,161	140,173	143,760	157,326	136,867	120,767	91,677
1879	75,387	62,837	71,874	87,302	100,040	83,802	73,120
1880	116,366	72,030	69,250	72,534	76,622	78,200	56,502
1881	95,226	91,011	97,829	124,831	115,683	86,083	81,609
1882	114,220	92,472	96,596	107,628	119,714	114,382	122,110
Total	538,360	458,523	479,309	549,621	548,926	483,234	425,018

Year	Aug.	Sept.	Oct.	Nov.	Dec.	Annual total
1878	113,701	120,607	138,997	127,656	93,032	1,521,724
1879	131,702	196,135	429,115	369,390	233,795	1,914,499
1880	74,127	87,618	91,218	99,459	93,264	987,170
1881	86,316	109,837	181,519	180,683	151,846	1,402,473
1882	151,779	159,604	156,065	128,040	122,517	1,485,127
Total	557,625	673,801	996,914	905,228	694,454	7,311,013

The deaths recorded average a little under a million and a half per annum, but in 1880 they were less than a million, and in 1879 nearly two millions. In that disastrous year one district or county, that of Aligarh, lost nearly half a million of its population. The chief difference between 1879 and 1880, from the meteorological